COMPLETE NUMERICAL SHEET OF CH - 11

HEAT

TOPIC – 1: TEMPERATURE:

Q 1: The body temperature is 98.4 ^oF. What is this temperature on Celsius scale? [Ans: 36.89 ^oC]

Q 2: At what temperature do the Fahrenheit and Celsius scales coincide? [Ans: - 40]

[2006]
Q 3: Celsius thermometer in a laboratory reads the surroundings temperature as 30 ^oC what is the temperature in the Fahrenheit and absolute scale? [Ans: 86 F, 303 K]

TOPIC - 2: THERMAL EXPANSIONS:

Q 1: A steel rod has a length of 10 m at a temperature of 25 ^oC. What will be the increase in length if the temperature is raised to 35 ^oC? Given $\alpha = 1.1 \times 10^{-5}\ K^{-1}$. [Ans: 1.1×10^{-3} m]

Q 2: A steel rod has a length of exactly 0.2 cm at 30 ^oC. What will be its length at 60 ^oC? α for steel = $1.1 \times 10^{-5}\ C^{-1}$. [Ans: 0.20066 cm]

[2019]
Q 3: Find the change in volume of an aluminum sphere of 0.4 m radius when it is heated from 0 ^oC to 100 ^oC. $\alpha = 2.4 \times 10^{-5}\ C^{-1}$. [Ans: 0.00193 m^3]

[2006]
Q 4: Find the change in volume of brass sphere of 0.6 m diameters when it is heated from 30 ^oC to 100 ^oC, $\alpha = 1.9 \times 10^{-5}\ C^{-1}$ [Ans: $4.5 \times 10^{-4}\ m^3$]

[2008]
Q 5: A steel bar is 10 m in length at – 2.5 ^oC. What will be the change in its length at 25 ^oC? β for steel = $3.3 \times 10^{-5}\ K^{-1}$. [Ans: 3.025×10^{-3} m]

[2002 PE]
Q 6: A cylinder of diameter 1 cm at 30 ^oC is to be slide into a hole in a steel plate. The hole has a diameter of 0.99970 cm at 30 ^oC. To what temperature must the plate be heated? $\alpha = 1.1 \times 10^{-5}\ C^{-1}$. [Ans: 57.28 ^oC]

[2005]
Q 7: A brass ring of 20 cm diameter is to be mounted on a metallic rod of 20.02 cm diameter at 20 ^oC. To what temperature should the ring be heated? $\alpha = 1.9 \times 10^{-5}\ C^{-1}$. [Ans: 72.63 ^oC]

TOPIC – 3: GAS LAWS:

[1983]

Q 1: **A tank containing 0.1 m^3 of nitrogen at room temperature and at a pressure of 8×10^6 N / m^2 are connected through a valve to an empty tank of volume 0.4 m^3. The valve is opened and the nitrogen is allowed to expand. After the system returns to room temperature, what is the pressure of the tank? [Ans: 1.6×10^6 N/m^2]**

[1991]

Q 2: **One gram mole of a gas occupies a volume of 24.93 m^3 at a pressure of 500 N/m^2. Find the temperature of the gas in centigrade. [Ans: 1226.45 ^oC]**

[1996]

Q 3: **A tank contains 20 liters of air at 30 ^oC and 5.01×10^5 N/m^2 pressure. What is the mass of air and what volume it occupy at one atm pressure and at 0 ^oC? The average molecular mass of air is 28.8 g / mol. [Ans: 114.3 g, 0.089 m^3]**

[2000]

Q 4: **Calculate the volume occupied by a gram mole of gas at 10 ^oC and pressure of one atmosphere. 1 atm = 1.01×10^5 N/m^2. [Ans: 0.023 m^3]**

[2003 P.M]

Q 5: **An air storage tank whose volume is 110 lit contains 2 kg of air at a pressure of 15 atm. How much air would have to be forced into the tank to increase the pressure to 18 atm, assuming no change in temperature. [Ans: 0.4 kg]**

[2009]

Q 6: **A scientist stores 22 g of a gas in tank at 1200 atm. Overnight the tank develops slight leakage and the pressure drops to 950 atm. Calculate the mass of the gas escaped. [Ans: 4.59 g]**

Q 7: **An air storage tank whose volume is 112 liters contains 3 kg of air at a pressure of 18 atmospheres. How much air would have to be forced into the tank to increase the pressure to 21 atmospheres, assuming no change in temperature? [Ans: 0.5 kg]**

Q 8: **Calculate volume occupied by a gram mole of a gas at 0^oC& at a pressure of 1 atm. [Ans: 0.0224 m^3]**

TOPIC – 4: ROOT MEAN SQUARE SPEED

[1985][1998][2002 P.M]

Q 1: **Find root mean square velocity of hydrogen gas molecule at 100 ^oC takes the mass of the hydrogen molecule 3.32×10^{-27} kg. [Ans: 2156.6 m/s]**

[1990]

Q 2: **At certain temperature the average K.E of hydrogen molecule is 6.2×10^{-21} J. If the mass of hydrogen molecule is 3.32×10^{-27} kg then find temperature and mean square velocity of hydrogen molecule. [Ans: 299.5 K, 3.735×10^6 m/s]**

[1996]
Q 3: **Find the root mean square speed of the nitrogen molecule at 27 ^{o}C. Mass of nitrogen molecule is 4.67 x 10^{-26} kg. [Ans: 515.7 m/s]**

[2000]
Q 4: **Determine the average value of kinetic energy of gas at 300 K. [Ans: 6.21 x 10^{-21} J]**

[2004]
Q 5: **Calculate density of hydrogen gas, considering it to be an ideal gas when the R.M.S of hydrogen molecule is 1850 m/s at 0 ^{o}C and at 1 atm pressure. [Ans: 0.088 kg/m ^{3}]**

[2006]
Q 6: **Calculate R.M.S speed of hydrogen molecule at 800 K. [Ans: 3158.6 m/s]**

[2014]
Q 7: **Find root mean square speed of oxygen molecule at 800 K. Its molar mass is 32 gm.**

Q 8 a: **Determine the average value of the kinetic energy of the particles of an ideal gas at 0 ^{o}C and at 50 ^{o}C. [Ans: 5.65 x 10^{-21} J, 6.68 x 10^{-21} J]**

Q 8 b: **What is K.E per mole of an ideal gas at these temperature?[Ans: 3404.5 J/mol, 4026.2 J/mol]**

TOPIC – 5: HEAT CAPACITY

Q 1: **A 50 g piece of metal is heated to 100 ^{o}C and then dropped into the copper calorimeter of mass 400 g containing 400 g of water initially at 20 ^{o} C. If the final equilibrium temperature of the system is 22.4 ^{o}C, find specific heat of the metal. Specific heat of the copper is 386 J/ Kg ^{o}K. [Ans: 1134.68 J/Kg ^{o}K]**

[2011]
Q 2: **A 200 g piece of metal is heated to 150 ^{o}C and then dropped into an aluminum calorimeter of mass 500 g containing 500 g of water initially at 25 ^{o} C. Find the equilibrium temperature of the system if the specific heat of metal is 128.1 J / Kg ^{o}K. Specific heat of aluminum is 903 J/Kg ^{o}K, while specific heat of water 4200 J/kg ^{o}K [Ans: 299.24 K]**

TOPIC – 6: 1ST LAW OF THERMODYNAMICS

Q 1: **In a certain process 400 J of heat are supplied to a system & at same time 150 J of work are done by the system. What is the increase in the internal energy of the system? [Ans: 250 J]**

[1991]
Q 2: **A cylinder contains an ideal gas below the gas in the cylinder in supplied 3000 J of heat and the piston rises by 0.35 m while the internal energy of the gas increases by 400 J. Calculate work done by the system. [Ans: 2600 J]**

[1994][2003P.E]

Q 3: **1200 J of heat energy are supplied to the system at constant pressure. The internal energy of the system increased by 750 J and the volume 4.5 m ^{3}, find the work done against the piston and pressure on the piston. [Ans: 450 J, 100 N/m ^{2}]**

[1996][2000][2002P.M][2009]

Q 4: **When 2000 J of heat energy is supplied to a gas in cylinder at constant pressure of 1.01 x 10 ^{5} N/m ^{2}, the piston of area of cross section of 2 x 10 $^{-2}$ m ^{2} moves through 0.5 m calculate wok done & the increase in the internal energy. [Ans: 1010 J, 990 J]**

[2002]

Q 5: **If one mole of monatomic gas is heated at constant pressure from –30 ^{o}C to 20 ^{o}C, find change in internal energy & work done during process. [Ans: 623.5 J, 415.7 J]**

Q 6: **A system absorbs 1000 J of heat & delivers 600 J of work while losing 100 J of heat by conduction to the atmosphere. Calculate change in internal energy of system. [Ans: 300 J]**

Q 7: **A thermodynamic system undergoes a process in which it internal energy decreases by 300 J. If at the same time 120 J of work is done on the system, find the heat transferred to or from the system. [Ans: - 420 J]**

Q 8: **There is an increase of internal energy by 400 J when 800 J of work is done by a system. What is the amount of heat supplied during this process? [Ans: 1200 J]**

TOPIC – 7: CARNOT ENGINE

[1987]

Q 1: **The efficiency of heat engine is 50%. If the temperature of the cold reservoir is 300 K, find the temperature of the hot reservoir. [Ans: 600 K]**

[1990]

Q 2: **A heat engine performs work 0.4166 watts in one hour and rejects 4500 J of heat energy to the sink. What is the efficiency of the engine? [Ans: 25%]**

[1995]

Q 3: **A heat engine performs works at the rate of 500 KW. The efficiency of the engine is 30%, calculate the loss of heat per hour. [Ans: 4.2 x 10 ^{9} J]**

[1997][2000]

Q 4: **A Carnot engine whose low temperature reservoir is 7 ^{o}C has an efficiency of 40%. It is desired to increase the efficiency to 50%. By how much degree must the temperature of high temperature reservoir be increased? [Ans: 93.4 ^{o}C]**

[1999]

Q 5: **Find efficiency of a Carnot engine working between 100 ^{o}C and 50 ^{o}C [Ans: 13.4%]**

[2001]

Q 6: **An ideal heat engine operates in Carnot's cycle between temperature 227 ^{o}C and 127 ^{o}C and its absorbs 600 J of heat energy, find (i) work done per cycle (ii) efficiency of the engine. [Ans: 20%, 120 J]**

[2002 P.E]

Q 7: **A heat engine performs 1000 J of work at the same time rejects 4000 J of heat energy to the cold reservoir. What is the efficiency of the engine? If the difference of temperature b/w the sink & the source of this engine is 75 ^{o}C, find temperature of its source. [Ans: 20%, 375 K]**

[2003 P.E][2003 P.M][2004]

Q 8: **The low temperature reservoir of Carnot engine is at – 3 ^{o}C and has an efficiency of 40%. It is desired to increase the efficiency to 50%. By how many degrees should the temperature of hot reservoir be increased? [Ans: 90 ^{o}C]**

[2008]

Q 9: **A Carnot engine performs 2000 J of work and rejects 4000 J of heat to the sink. If the difference of temperature between the source and the sink is 85 ^{o}C, find the temperature of source and sink. [Ans: 255 K, 170 K]**

[2010][2015]

Q 10: **A heat engine performing 400 J of work in each cycle has an efficiency of 25%. How much heat is absorbed and rejected in each cycle? [Ans: 1600 J, 1200 J]**

[2012][2016]

Q 11: **A Carnot engine whose low temperature reservoir is 200 K has an efficiency of 50 %. It is desired to increase it to 75 %. By how many degrees must temperature of low temperature reservoir be decreased if temperature of higher reservoir remains constant? [Ans: 100 K]**

[2013]

Q 12: **The difference of temperature of hot and cold body is 120^{o}C. If heat engine is 30 % efficient, find the temperature of hot and cold body.**

TOPIC – 8: ENTROPY

[2005]

Q 2: **A 100 g copper block is heated in boiling water for ten minutes and then dropped into 150 g of water at 30 ^{o}C in a 200 g calorimeter. If the temperature of water is raised to 33.6 ^{o}C. Determine the specific heat of the material of calorimeter. (S for copper = 386 J/Kg ^{o}C) [Ans: 409.77 J/Kg]**

Q 3: **A 2 kg iron block is taken from furnace when its temperature was 650 ^{o}C and place on a large block of ice at 0 ^{o}C. Assuming that all the heat given up by the iron is used to melt the ice. How much ice is melted? [Ans: 1.93 Kg]**